

III. *Observations concerning the Height of the Barometer, at different Elevations above the Surface of the Earth, in a Letter to the Publisher from the Learned Dr. Nettleton.*

S I R,

BEING curious to learn by Observation, how far the Mercury will descend in the Tube at any given Elevation, for which there is sufficient Opportunity hereabouts, I propos'd to take the Altitude of some of our highest Hills; but, when we attempted it, we found our Observations so disturbed by Refractions, that we cou'd come to no Certainty. Having measur'd one Hill of a considerable Height, in a clear Day, and observed the Mercury at the Bottom and at the Top, we found, according to that Estimation, that about 90 Feet, or upwards, were required to make the Mercury fall one Tenth of an Inch; but coming afterwards to repeat the Experiment on a cloudy Day, when the Air was somewhat gross and hazy, we found the small Angles so much augmented by Refraction, as to make the Hill much higher than before, tho' they were taken carefully with very good Instruments, both at that Time and before. I afterwards frequently observ'd at home, by pointing the Quadrant to the Tops of some of our neighbouring Mountains, that they wou'd appear higher in the Morning before Sun-rise, and also late in the Evening, than at Noon, in a clear Day, by several Minutes: Particularly, one Morning in *December* last, when the Vapours lay condens'd in the Vallies, and the Air above was very pure, the Top of a Mountain, at some Distance from

from hence, appear'd more elevated, by above 30 Minutes, than it had done in the Beginning of *September* about Noon, on a very clear Day. From whence it appears, that the Refraction is at some times greater than at others ; but probably 'tis always very considerable, and, as there is no certain Rule to make Allowance for it, it seems likely, that all Observations made on very high Hills, especially when view'd at a Distance, and under small Angles, as they commonly are, are uncertain, and scarce to be depended on, generally erring in making the Heights greater than they really are.

I then proceeded to observe, as near as I was able, the Position of the Mercury in some smaller perpendicular Directions, which we cou'd measure with a Line, and also on the Tops of some Hills of a moderate Height, whose Altitude we cou'd observe most commodiously, and, by taking the Angles large, avoid the Danger of any considerable Refraction.

At the Bottom of the Tower of *Halifax* Church, the Mercury stood at 29 *Inch.* 78 *Dec.* At the Top it subsided to 29. 66. The Height of the Place, where the Observation was made, was found to be 102 Feet.

At the Bottom of a Coal-Mine, near this Place, the Mercury stood at 29. 48. At the Top, it fell to 29. 32. The Depth of the Mine, being measured, was found to be 140 Feet.

At the Bottom of another Mine, the Mercury was observed to stand at 29. 50. At the Top, it fell to 29. 23. The Depth of this Mine was 236 Feet.

At the Foot of a small Hill, whose Height we cou'd measure very exactly, the Mercury stood at 29. 81. At the Top it fell to 29. 45. The Height of the Hill was 312 Feet.

At the Bottom of *Halifax* Hill, commonly call'd the Bank, the Mercury was observed to stand at 30. 00.

At the Top, it fell to 29. 41. The Height of this Hill was found to be 507 Feet.

Our Mathematicians do demonstrate, that the Density of the Air decreases in a Geometrical Progreſſion, as the Elevation encreaſes in an Arithmetical one, and confequently, that the Logarithms of the Densities are as the Elevations reciprocally. But the Weight of the Air being as its Density, and the Height of the Mercury in the Barometer being always proportional to the Air's Weight, it follows, that the Logarithms of the Heights of the Mercury are, reciprocally, as the Elevations: Whence having found by Obſervation, what Elevation is requir'd to make the Mercury ſtand at any Height, it will be eaſy to determine, how much is requiſite to reduce it to any other Height propos'd. If we make 30 Inches the Standard Height of the Mercury, equal to Unity, and ſuppoſe an Elevation of 85 Feet be requir'd to make it fall one Tenth of an Inch from that Height, as by theſe Obſervations it is very nearly; then as the Logarithm of  $\frac{30,0}{29,9}$  is to 85, ſo is the Log.

$\frac{30,0}{29,5}$  to the Number of Feet requir'd to make it fall Half an Inch, and ſo of the reſt. When the Mercury ſtands above 30 Inches, the Numbers will be negative, and ſhew the Spaces deſcending; by which Method I computed the following Tables.

The latter, which contains the Differences of the Numbers in the former, was of very great Uſe to me, when, in theſe Experiments, the Mercury ſtood at any other Height in the Tube, beſides 30 Inches, and fell any Number of Tenths, or Parts of a Tenth, by adding the Numbers anſwering thereto, or proportionable Parts of them, to find the Elevation requir'd in the Table, to make the Mercury fall ſo much, and thereby readily  
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to compare the Heights found by Observation therewith. And though some small Errors, in the Observations, do make them vary a little from each other, yet in the main, they agree as near as possible with the Numbers of the Table ; as did also several other Experiments too long to mention, which makes me believe those Numbers are not far from the Truth ; but of that you will be best able to judge, by comparing these Experiments with others of the same Kind.

That the Air is colder, as well as more light and rare, in Places that are situated high, than it is in the Vallies and low Grounds, is generally known; and in order to learn, how much it might be so, I got a Friend of mine, who lives higher than we do here, to observe the portable Barometer and Thermometer, at his House, for some Days, being plac'd as near as possible in the same Circumstances with mine ; and we found his Barometer stood at a Medium for 20 Days, 3 Tenths lower than mine, and the Thermometer 3. *deg.* 2. lower ; allowing for the Difference of the Instruments, which had been observed before.

At another Place the Barometer, at a Medium for 14 Days, stood lower by 4. 46. and the Thermometer was lower by 4. *deg.* 4. At another Place, which was very high upon the Moors, the Barometer, at a Medium for ten Days, stood lower by 0. 65. and the Thermometer fell 7°.

A Table shewing the Number of Feet ascending, requir'd to make the Mercury fall to any given Height in the Tube, from 30 to 26 Inches. As also the Number of Feet descending, requir'd to make the Mercury rise, from 30 to 31 Inches.

In. Dec.	Feet Dec.	In. Dec.	Feet Dec.
31	0834	29	27
30	9752	28	27
30	8670	27	27
30	7587	26	27
30	6504	25	27
30	5420	24	27
30	4337	23	27
30	3253	22	27
30	2169	21	27
30	184	20	27
30	000	19	27
29	985	18	27
29	8170	17	27
29	7255	16	27
29	6341	15	27
29	5427	14	27
29	4514	13	27
29	3601	12	27
29	2688	11	27
29	1775	10	27
29	0863	09	27
28	9951	08	27
28	81039	07	27
28	71127	06	27
28	61216	05	27
28	51305	04	27
28	41395	03	27
28	31485	02	27
28	21575	01	27
28	11665	00	27
28	01756	47	27

A Table shewing the Number of Feet requir'd to make the Mercury fall one Tenth of an Inch from any given Height in the Tube, from 31 to 26 Inches.

In. Dec.	Feet Dec.	In. Dec.	Feet Dec.
31	082	27	991
30	982	27	891
30	882	27	792
30	783	27	692
30	683	27	592
30	583	27	493
30	483	27	393
30	384	27	293
30	284	27	194
30	184	27	094
30	085	26	994
29	985	26	895
29	885	26	795
29	785	26	695
29	686	26	596
29	586	26	496
29	486	26	396
29	387	26	297
29	287	26	197
29	187	26	098
29	087	25	993
28	988	24	888
28	888	24	788
28	788	24	689
28	689	24	589
28	589	24	489
28	489	24	390
28	390	24	290
28	290	24	190
28	190	24	091